

**U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM**

SCIENTIFIC NAME: *Lexingtonia dolabelloides*

COMMON NAME: slabside pearlymussel

LEAD REGION: 4

INFORMATION CURRENT AS OF: March 2010

STATUS/ACTION:

☐ Species assessment - determined species did not meet the definition of endangered or threatened under the Act and, therefore, was not elevated to Candidate status

☐ New candidate

☒ Continuing candidate

☐ Non-petitioned

☒ Petitioned - Date petition received: May 11, 2004

☐ 90-day positive - FR date:

☐ 12-month warranted but precluded - FR date:

☐ Did the petition request a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:

a. Is listing warranted (if yes, see summary of threats below)? yes

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? yes

c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded. Higher priority listing actions, including court-approved settlements, court-ordered and statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for the species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The "Progress on Revising the Lists" section of the current CNOR (<http://endangered.fws.gov/>) provides information on listing actions taken during the last 12 months.

☐ Listing priority change

Former LP: ☐

New LP: ☐

Date when the species first became a Candidate (as currently defined):

☐ Candidate removal: Former LP: ☐

☐ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.

☐ U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

- ☐ F – Range is no longer a U.S. territory.
- ☐ I – Insufficient information exists on biological vulnerability and threats to support listing.
- ☐ M – Taxon mistakenly included in past notice of review.
- ☐ N – Taxon does not meet the Act’s definition of “species.”
- ☐ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Clams

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Alabama, Kentucky, Mississippi, Tennessee, Virginia

CURRENT STATES/ COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Alabama, Mississippi, Tennessee, Virginia

LAND OWNERSHIP:

The slabside pearlymussel occurs in streams that generally run through private lands. A small percentage (~5%) of its current range occurs on public lands in the Duck River in Tennessee.

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LEAD FIELD OFFICE CONTACT: Cookeville, Tennessee, Field Office, Stephanie Chance, 931/528-6481, extension 211, stephanie_chance@fws.gov

BIOLOGICAL INFORMATION

The slabside pearlymussel, *Lexingtonia dolabelloides* (I. Lea, 1840), has recently been published as *Pleuroanaia dolabelloides* in the “Freshwater Mussels of Alabama and the Mobile Basin in Georgia, Mississippi, and Tennessee” based on unpublished phylogenetic analyses and shell morphology (Williams *et al.* 2008, pp 584-593). However, the species is still recognized by its former name in the “Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Mollusks, Second Edition” (Turgeon *et al.* 1998, p. 35). Therefore, the Service will retain *Lexingtonia* for the purposes of this assessment.

The following description, biology, and life history of the slabside pearlymussel is taken from Parmalee and Bogan (1998, pp. 150-152) and others cited in their book “The Freshwater Mussels of Tennessee.” The slabside pearlymussel is a moderately-sized mussel that reaches about 9 centimeters (3.5 inches) in length. The shape of the shell is subtriangular, and the very solid, heavy valves are moderately inflated. Shell texture is smooth and somewhat shiny in young specimens, becoming duller with age. Shell color is greenish yellow, becoming brownish with age, with a few broken green rays or blotches, particularly in young individuals. Internally, the pseudocardinal teeth (raised, interlocking hinges used to stabilize opposing shell halves) are triangular or blade-like in shape. There is a single lateral tooth. The color of the nacre (mother-of-pearl) is white, or rarely, straw-colored.

Adult freshwater mussels are filter-feeders, siphoning (drawing in or expelling water) phytoplankton, diatoms, and other microorganisms from the water column. For their first several months juvenile mussels employ foot feeding (ingesting food through the sweeping motions of a ciliated foot), and are thus suspension feeders that feed on algae and detritus. Mussels tend to grow relatively rapidly for the first few years, then slow appreciably at sexual maturity (when energy is being diverted from growth to reproductive activities). As a group, mussels are extremely long-lived, living from a few decades to a maximum of approximately 200 years. Large, heavy-shelled riverine species tend to have longer life spans. Samples from approximately 150 shells of the slabside pearlymussel from the North Fork Holston River were thin-sectioned for age determination. The maximum age exceeded 40 years (Grobler *et al.* 2005, p. 65).

Most mussels, including the slabside pearlymussel, have separate sexes. Males expel clouds of sperm into the water column, which are drawn in by females through their incurrent siphons. Fertilization takes place internally, and the resulting zygotes develop into specialized larvae termed glochidia inside the water tubes of her gills. The slabside pearlymussel utilizes all four gills as a marsupium (portion of a brooding female's gill which holds embryos and glochidia) for its glochidia. It is thought to have a spring or early summer fertilization period with the glochidia being released during the summer in the form of conglomerates, which are similar to cold capsules or gelatinous containers with scores of glochidia contained within. Conglomerate masses often mimic food items of glochidial fish hosts. Glochidia must come into contact with a specific host fish(es) in order for their survival to be ensured. Without the proper host fish, the glochidia will perish.

Slabside pearlymussel conglomerates are undescribed, but they are probably shaped like some sort of common fish food item, such as insect larvae, similar to other mussels that expel conglomerates. The slabside pearlymussel's host fishes, which include six species of shiners (popeye shiner, *Notropis ariommus*; rosyface shiner, *Notropis rubellus*; saffron shiner, *Notropis rubricroceus*; silver shiner, *Notropis photogenis*; telescope shiner, *Notropis telescopus*; and Tennessee shiner, *Notropis leuciodus*), are tricked into thinking that they have an easy meal when in fact they have infected themselves with mussel glochidia.

After a few weeks parasitizing the fishes' gill tissues, newly-metamorphosed juveniles drop off to begin a free-living existence on the stream bottom. Unless they drop off in suitable habitat, they will die. Thus, the complex life history of the slabside pearlymussel and other mussels has many critical steps that may prevent successful reproduction and/or recruitment of juveniles to existing populations.

The slabside pearlymussel is primarily a large creek to moderately-sized river species, inhabiting sand, fine gravel, and cobble substrates in relatively shallow riffles and shoals with moderate current (Parmalee and Bogan 1998, p. 152). This species requires flowing, well-oxygenated waters to thrive.

Most studies of the distribution and population status on the slabside pearlymussel presented below were conducted after the early 1960s. Gordon and Layzer (1989), Winston and Neves

(1997), and Parmalee and Bogan (1998, pp. 150-151) give most of the references for survey work in regional streams. Current, unpublished distribution and status information is taken from State Heritage Programs, agency biologists, and other knowledgeable individuals.

The slabside pearlymussel is a Cumberlandian Region mussel, meaning it is restricted to the Cumberland (in Kentucky and Tennessee) and Tennessee (in Alabama, Tennessee, and Virginia) River systems. Historically, this species occurred in the lower Cumberland River main stem from about the Caney Fork downstream to the vicinity of the Kentucky State line, and in the Tennessee River main stem from eastern Tennessee to western Tennessee. Records are known from two Cumberland River tributaries, the Caney Fork and Red River. In addition, it is known from nearly 30 Tennessee River system tributaries, including the South Fork Powell River, Powell River, Puckell Creek, Clinch River, North Fork Holston River, Big Moccasin Creek, Middle Fork Holston River, South Fork Holston River, Holston River, French Broad River, West Prong Little Pigeon River, Tellico River, Little Tennessee River, Hiwassee River, Sequatchie River, Paint Rock River, Larkin Fork, Estill Fork, Hurricane Creek, Flint River, Limestone Creek, Elk River, Sugar Creek, Bear Creek, Duck River, North Fork Creek, Big Rock Creek, and Buffalo River (Gordon and Layzer 1989; Winston and Neves 1997; and Parmalee and Bogan 1998, pp. 204-205). Undocumented, but now lost, populations likely occurred in other Cumberlandian Region tributary systems.

Populations of the slabside pearlymussel are generally considered extant (current) if live or fresh dead specimens have been collected since circa 1980. Currently, it is limited to 10 populations in the Tennessee River system, having been extirpated (eliminated) from the Cumberland River system and from the Tennessee River main stem. This species is still known from the Powell River, Clinch River, North Fork Holston River, Big Moccasin Creek, Middle Fork Holston River, Hiwassee River, Paint Rock River, Larkin Fork, Estill Fork, Hurricane Creek, Elk River, Buffalo River, Bear Creek, and Duck River. Where two or more stream populations occur contiguously with no absolute barriers (e.g., large impoundments) or long reaches of unoccupied habitat, they are considered to represent a single population segment. The Paint Rock River system (including Larkin Fork, Estill Fork, and Hurricane Creek) is considered a single population segment but it occurs only in the lower mile or so of the three tributary streams. The slabside pearlymussel has been eliminated from about three-fifths of the total number of streams from which it was historically known. It may also have occurred historically in other poorly sampled or unsampled streams within its historical range.

The slabside pearlymussel was fairly widespread and common in many Cumberlandian Region streams based on collections made in the early 1900s. However, its decline in certain streams may have begun before European colonization. The presence of the slabside pearlymussel in several streams, particularly those in the middle Tennessee River system, is known only by records from aboriginal “kitchen middens” (archeological records of mussels used as food from several hundred to several thousand years before present). The slabside pearlymussel was considered rare by mussel experts as early as 1970 (Stansbery 1971, p.13), which represents the first attempt to compile such a list. The extirpation of this species from numerous streams within its historical range indicates that substantial population losses and range reductions have occurred.

The extant occurrences in the Tennessee River system represent 10 isolated populations. Population size data gathered during the past decade or two indicates that the slabside pearl mussel is rare (experienced collectors may find four or fewer specimens per site of occurrence) in about half of its extant populations. Only a few specimens have been found in the Powell River since 1988, therefore, this population may be considered extremely rare (Ahlstedt *et al.* 2005, p. 9). In 2009, 4 individuals were collected in the Powell River (M. Johnson, Virginia Tech., pers. comm. 2010). A single live individual was found in 2006 in Big Moccasin Creek, Virginia (Ostby *et al.* 2006, p. 3). The slabside pearl mussel is uncommon to rare in the Clinch River, with only a few individuals found per effort (Ahlstedt *et al.* 2005, p. 8). The VDGIF has observed a slight decline in the species at Cleveland Island on the Clinch River based on quantitative surveys conducted in 2002 and 2008 (N. Eckert, VDGIF, pers. comm. 2010). Approximately 20 individuals were found at one site in the Elk River, Tennessee, in 2005 (Tennessee Valley Authority (TVA), unpublished data, 2009). A small population is limited to a six-mile reach of Bear Creek in Mississippi, its only occurrence in that state (R.L. Jones, Mississippi Museum of Natural Science, pers. comm. 2007). Viability of the Bear Creek population is questionable. Small populations of this long-lived species may persist for decades despite total recruitment failure. The species has undergone decline in the North and Middle Forks of the Holston River (Jones and Neves 2005, pp. 8-9). This is especially true for the North Fork, where the species has nearly been eliminated (S. Hanlon, Service, pers. comm. 2009). The cause for the observed die-offs is unknown (Jones and Neves 2007, p. 479), but may be related to agricultural practices (S. Hanlon, Service, pers. comm. 2009).

Only two populations are recruiting as evidenced by finding juveniles (i.e., Duck and Paint Rock rivers). The slabside pearl mussel is found at numerous sites in the Duck River within a 40 mile (mi) (64 kilometer (km)) reach, and is found at numerous sites within a 45 mi (72 km) reach of the Paint Rock (Ahlstedt *et al.* 2004, p. 84; Fobian *et al.* 2008, pp. 15-16).

A recent genetic study of major population centers concluded that the species is not a complex (Grobler *et al.* 2005, p. 1). However, the population in the Duck River was deemed distinct enough from those in the middle (i.e., Paint Rock River) and upper (i.e., Clinch, North and Middle Forks Holston Rivers) Tennessee River system to warrant recognition as a distinct management unit when considering future propagation and reintroduction efforts.

In summary, current status information for most of the 10 populations deemed to be extant is available from recent periodic sampling efforts (sometimes annually) and other field studies. Comprehensive surveys have taken place in the Middle and North Forks Holston River, Paint Rock River, and Duck River in the past several years. Based on recent information, the overall population of the slabside pearl mussel is declining rangewide and the species remains in good numbers and appears viable in just four streams. Two of the four largest populations in the mid-1990s have undergone drastic recent declines (i.e., North and Middle Forks Holston Rivers), especially in the North Fork. Most of the other populations are of questionable viability and may be on the verge of extirpation (e.g., Powell, Hiwassee Rivers; Big Moccasin, Bear Creeks).

THREATS

A. The present or threatened destruction, modification, or curtailment of its habitat or range.

The decline of the slabside pearlymussel in the Cumberlandian Region and other mussel species in the eastern United States is primarily the result of habitat loss and degradation. These losses have been well documented for more than 130 years. Chief among the causes of decline are impoundments, stream channel alterations, water pollution, and sedimentation (Williams *et al.* 1993, p. 7; Neves 1993, pp. 4-5; Neves *et al.* 1997, pp. 60-78). Specific information presented in this section on threats to the slabside pearlymussel and causes of its decline were gathered primarily from these published sources and other studies generally cited in their works, except where noted.

Impoundments result in the dramatic modification of riffle and shoal habitats and the resulting loss of mussel resources, especially in larger rivers. Impoundment impacts are most profound in riffle and shoal areas, which harbor the largest assemblages of mussel species, including the slabside pearlymussel. Dams interrupt most of a river's ecological processes by modifying flood pulses; controlling impounded water elevations; altering water flow, sediments, nutrients, energy inputs and outputs; increasing depth; decreasing habitat heterogeneity; and decreasing stability due to subsequent sedimentation. The reproductive process of riverine mussels is generally disrupted by impoundments making the slabside pearlymussel unable to successfully reproduce and recruit under reservoir conditions.

In addition, dams can also seriously alter downstream water quality and riverine habitat, and negatively impact tailwater mussel populations. These changes include thermal alterations immediately below dams; changes in channel characteristics, habitat availability, and flow regime; daily discharge fluctuations; increased silt loads; and altered host fish communities. Coldwater releases from large non-navigational dams and scouring of the river bed from highly fluctuating, turbulent tailwater flows have also been implicated in the demise of mussel faunas.

Population losses due to impoundments have probably contributed more to the decline of the slabside pearlymussel and other Cumberlandian Region mussels than any other single factor. The majority of the Tennessee and Cumberland River main stems and many of their largest tributaries are now impounded. For example, approximately 2,300 river mi (3,700 river km) (about 20 percent) of the Tennessee River and its tributaries with drainage areas of 25 square mi (65 square km) or greater were impounded by the TVA by 1971 (TVA 1971, p. 5). The subsequent completion of additional major impoundments on tributary streams (e.g., Duck River in 1976, Little Tennessee River in 1979) significantly increased the total miles impounded behind the 36 major dams in the Tennessee River system. Approximately 90 percent of the 562-mi (904 km) length of the Cumberland River downstream of Cumberland Falls is either impounded (three locks and dams and Wolf Creek Dam) or otherwise adversely impacted by coldwater discharges from Wolf Creek Dam. Other major U.S. Army Corps of Engineers (Corps) impoundments on Cumberland River tributaries (e.g., Obey River, Caney Fork) have inundated over 100 mi (161 km) of riverine habitat for the slabside pearlymussel.

Instream gravel mining has been implicated in the destruction of mussel populations. Negative impacts associated with gravel mining include stream channel modifications (e.g., altered habitat, disrupted flow patterns, sediment transport), water quality modifications (e.g., increased

turbidity, reduced light penetration, increased temperature), macroinvertebrate population changes (e.g., elimination, habitat disruption, increased sedimentation), and changes in fish populations (e.g., impacts to spawning and nursery habitat, food web disruptions) (Kanehl and Lyons 1992, p. 26-27). Gravel mining activities threaten the slabside pearlymussel populations in the Powell and Elk Rivers in the Tennessee River system.

Heavy metal-rich drainage from coal mining and associated sedimentation has adversely impacted portions of the upper Tennessee River system in Virginia. The low pH commonly associated with mine runoff can reduce glochidial encystment (process of a glochidium attaching and becoming surrounded by tissues of a gill or fin of a fish host) rates. Acid mine runoff, thus, may be having local impacts on recruitment of the slabside pearlymussel. Powell River mussel populations were inversely correlated with coal fines in the substrate; when coal fines were present, decreased filtration times and increased movements were noted in laboratory-held mussels (Kitchel *et al.* 1981, p. 25). In a quantitative study in the Powell River, a decline of federally listed mussels and the long-term decrease in overall species composition since about 1980 was attributed to general stream degradation due primarily to coal mining activities in the headwaters (Ahlstedt and Tuberville 1997, pp. 74-76). Coal mining activities are increasing in the upper Tennessee River system in southwest Virginia. Numerous gray-water and black-water spill events have been documented in the Powell and Clinch River drainages over the past several years. Slabside pearlymussel and other mussel populations in the Clinch and Powell rivers are increasingly being threatened by this activity. There are populations of 16 federally listed mussels now occurring in these streams in addition to four candidate mussels.

Contaminants contained in point and non-point discharges can degrade water and substrate quality and adversely impact mussel populations. The effects are especially profound on juvenile mussels, which can readily ingest contaminants, and glochidia, which appear to be very sensitive to certain toxicants. Mussels are very intolerant of heavy metals, and even at low levels, certain heavy metals may inhibit glochidial attachment to fish hosts.

Sediment from the upper Clinch River was found to be toxic to juvenile mussels. Ahlstedt and Tuberville (1997, p. 75) surmised that the presence of toxins in the Clinch River “could explain some of the decline and lack of recruitment of mussels in the Virginia portion of the Clinch.” Numerous streams have experienced mussel and fish kills from toxic chemical spills and other causes (Neves 1987, pp. 7-8).

Siltation and general sedimentation runoff has been implicated in the decline of stream mussel populations. Sources of silt and sediment include poorly designed and executed timber harvesting operations and associated activities; complete clearing of riparian vegetation for agricultural, silvicultural, or other purposes; and those construction, mining, and other practices that allow exposed earth to enter streams. Specific impacts on mussels from silt and sediments include clogged gills thus reducing their feeding and respiratory efficiency, impaired reproductive activity, disrupted metabolic processes, reduced growth rates, substrate instability, and the physical smothering of mussels under a blanket of silt.

In summary, habitat loss and degradation represent significant threats to the slabside

pearlymussel. Severe degradation from impoundments, sedimentation, instream gravel mining, and contaminants threaten the habitat and water quality on which the slabside pearlymussel depends. Contaminants associated with coal mining (metals, other dissolved solids), domestic sewage (bacteria, nutrients), and agriculture (fertilizers, pesticides, herbicides, and animal waste) cause degradation of water quality and habitats through increased acidity and conductivity, instream oxygen deficiencies, excess nitrification, and excessive algal growths. Furthermore, these threats faced by the slabside pearlymussel from sources of sedimentation and contaminants are imminent; the result of ongoing projects that are expected to continue indefinitely, therefore, perpetuating these impacts. As a result of the imminence of these threats combined with the vulnerability of the remaining small populations to extirpation from natural and manmade threats, we have determined that the present or threatened destruction, modification, or curtailment of the slabside pearlymussel habitat and range represents a significant threat of high magnitude.

B. Overutilization for commercial, recreational, scientific, or educational purposes.

The slabside pearlymussel is not a commercially valuable species, but might be increasingly sought by collectors with its increasing rarity. Most stream reaches inhabited by this species are restricted, and its populations are small. Although scientific collecting is not thought to represent a significant threat, localized populations could become impacted and possibly extirpated by overcollecting, particularly if this activity is unregulated.

In summary, the slabside pearlymussel is not commercially utilized but might be increasingly sought for scientific or educational purposes as their rarity becomes known. Scientific collections will be controlled by the states through issuance of collection permits. We consider overutilization for commercial, recreational, scientific, or educational purposes to be a potential threat of low magnitude and imminence.

C. Disease or predation.

The occurrence of disease in mussels is virtually unknown. Several mussel die offs have been documented during the past 20 years (Neves 1987, pp. 8-11). Although the ultimate cause is unknown, some researchers believe that disease may be a factor.

Predation on the slabside pearlymussel by muskrats represents a localized threat, as determined by Neves and Odum (1989) in the upper North Fork Holston River in Virginia. They concluded that muskrat predation could limit the recovery potential of endangered mussel species or contribute to the local extirpation of already depleted mussel populations. Although other mammals (e.g., raccoon, mink) occasionally feed on mussels, the threat is not significant.

In summary, disease is not considered to be a current threat to the slabside pearlymussel. Predation does occur, but it is considered to be a normal aspect of the species' population dynamics and is not considered to pose an imminent threat to the species.

D. The inadequacy of existing regulatory mechanisms.

The States of Alabama, Kentucky, Mississippi, Tennessee, and Virginia prohibit the taking of

mussels for scientific purposes without a State collecting permit. However, enforcement of this permit requirement is difficult. Furthermore, State regulations do not generally protect mussels from other threats.

Existing authorities available to protect riverine ecosystems, such as the Clean Water Act (CWA), administered by the Environmental Protection Agency (EPA) and the Corps, provide little direct protection to the slabside pearl mussel. Non-point source pollution is not regulated and the Clean Water Act does not adequately protect the habitat from degradation caused by point source pollutants.

The slabside pearl mussel receives incidental protection under the Endangered Species Act of 1973, as amended (Act), due to the coexistence of other federally listed mussels in the same streams. However, this protection is specific to each species. Federal listing would provide additional protection for this species by (1) requiring Federal endangered species permits to collect or otherwise take this species and (2) requiring federal agencies to consult with the Service when projects they fund, authorize, or carry out may adversely affect the species.

In summary, population declines and degradation of habitat for the slabside pearl mussel are ongoing despite the protection afforded by State and federal laws and corresponding regulations. Despite these laws, sedimentation and nonpoint-source pollution continue to adversely affect the species. Because of the vulnerability of the small remaining populations of the slabside pearl mussel and the imminence of these threats, we find the inadequacy of existing regulatory mechanisms to be a significant threat of high magnitude.

E. Other natural or manmade factors affecting its continued existence.

The remaining populations of the slabside pearl mussel are generally small and geographically isolated. The patchy distribution pattern of populations in short river reaches makes them much more susceptible to extirpation from single catastrophic events, such as toxic chemical spills. Such a spill that occurred in the upper Clinch River in 1998 killed thousands of mussel specimens of several species, including three federally listed species. Furthermore, this level of isolation makes natural repopulation of any extirpated population impossible.

Population isolation prohibits the natural interchange of genetic material between populations, and small population size reduces the reservoir of genetic diversity within populations, which can lead to inbreeding depression (Allendorf and Luikart 2007, pp. 117-146). It is likely that some populations of the slabside pearl mussel are below the effective population size (Soulé 1980, pp. 162-264; Allendorf and Luikart 2007, pp. 147-170) required to maintain long-term genetic and population viability.

The present distribution and status of the slabside pearl mussel in the Tennessee River system may be indicative of the detrimental bottleneck effect resulting when the effective population size is not attained. A once large population of this species occurred throughout much of the lower two-thirds of the Tennessee River main stem and in several larger tributary systems. In this region, there were no absolute barriers to genetic interchange among its tributary sub-populations and those of its host fishes that occurred in various streams. With the completion of

numerous main stem Tennessee River dams during primarily the first half of this century, the main stem population was soon extirpated, and the remaining populations isolated. Whereas small isolated tributary populations of imperiled short-lived species (e.g., most fishes) would have theoretically died out within a decade or so after impoundment, the long-lived slabside pearlymussel would potentially take decades to expire post-impoundment. Without the level of genetic interchange the species experienced historically (i.e., without the reservoir barrier), many small isolated populations may be slowly dying out (e.g., Powell, Elk Rivers, Big Moccasin, Bear Creeks). Even given the improbable absence of the impacts addressed in factors A through D above, we may lose smaller isolated populations of this species to the devastating consequences of below-threshold effective population size. In reality, degradation of these isolated stream reaches resulting in ever decreasing patches of suitable habitat is contributing to the decline of the slabside pearlymussel.

Therefore, we have determined that the imminence of other natural and manmade factors, such as small, isolated populations and low genetic diversity, combined with localized extinctions from intentional or accidental toxic chemical spills, habitat modification and progressive degradation by nonpoint-source pollutants, and natural catastrophic changes to their habitat through flood scour or drought, threaten remaining populations of the slabside pearlymussel. We consider the magnitude of these threats to be high.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

The Service has implemented ecosystem management in conserving, restoring, and recovering Federal trust species and their habitats nationwide. Shute *et al.* (1997, pp. 448-453) summarized the ecosystem approach to the management of imperiled aquatic resources, provided a literature review on the subject, and recommended a series of steps for developing and implementing an ecosystem management program. These include prioritizing riverine systems in need of protection, identifying and partnering with all potential agencies and organizations with watershed interests, prioritizing ecosystem threats, identifying strategies to minimize or eliminate threats, and educating ecosystem inhabitants and other stakeholders.

The CWA has greatly reduced point discharge pollutants into streams and provides ways and means of addressing non-point source pollution as well. In December 2007, a Memorandum of Understanding (MOU) was executed by Regions III and IV of the United States Environmental Protection Agency, the Tennessee Department of Environment and Conservation, the Virginia Department of Environmental Quality, and the Virginia Department of Mines, Minerals, and Energy. This MOU establishes a working group for coordinating efforts among these parties to protect and restore the Clinch and Powell Rivers, and their fish and mussel faunas. Partnering with State and federal agencies and the coal industry, The Nature Conservancy (TNC) is addressing the complex issue of abandoned mine lands, which may continue to impact slabside pearlymussel populations, by working on the Coal Re-mining Initiative.

Numerous stakeholders have realized that restoring and protecting riparian habitat improves water quality and is crucial for mussels. The Service has partnered with TNC, and a legion of stakeholders, to initiate several watershed-based riparian habitat restoration projects on streams having diverse aquatic faunas within the Cumberlandian Region. Streams that harbor extant

populations of the slabside pearlymussel and are the focus of these riparian restoration efforts include the upper Clinch River, Tennessee and Virginia, and the Paint Rock River, Alabama and Tennessee. TNC also has selected the upper Clinch River, which has more species at risk mussels and fishes than any other small watershed in North America, as one of eight critical watersheds nationwide for protecting aquatic biodiversity (Master *et al.* 1998). Certain Cumberlandian Region streams with records of the slabside pearlymussel receive a level of State protection from being designated outstanding resource waters.

TNC has designated the community-based project on the Clinch River a bioreserve. Local citizens with water quality concerns for the Paint Rock River watershed, which has a fairly large, but declining, population of the slabside pearlymussel have established the Paint Rock River Initiative (PRRI). By working closely with key partners (e.g., Resource Conservation and Development Councils, Natural Resources Conservation Service (NRCS), numerous other agencies and organizations), riparian habitat restoration activities conducted by the Service and TNC are proceeding in high-biodiversity watersheds in the Cumberlandian Region. The Clinch River Bioreserve and PRRI field representatives work closely with landowners and other stakeholders to effect riparian and aquatic habitat restoration. On-the-ground efforts that have helped improve riverine habitat in Bioreserves and other watershed-based riparian restoration projects include reducing erosion by stabilizing streambanks and using no-till agricultural methods, controlling nutrient enrichment by carefully planning heavy livestock use areas, establishing buffer zones by erecting fencing and revegetating riparian areas, developing alternative water supplies for livestock, and implementing voluntary Best Management Practices to control run-off for a variety of agricultural and construction activities. Programs administered by the NRCS are becoming increasingly important tools used in addressing habitat concerns associated with impaired Cumberlandian Region streams.

New watershed-based habitat restoration projects with slabside pearlymussel populations are just getting underway. One of these is located on the Duck River (a Tennessee River tributary in Tennessee), which harbors a sizable, but localized, population of the slabside pearlymussel. A stress analysis is being planned for the Duck River. The stress analysis determines the location, type, severity, and extent of non-point source impacts facing that stream. Designed to function as a foundation for a holistic riparian habitat restoration program, priority reaches of high-quality habitat can be focused on for restoration activities once a stress analysis has been completed and accompanying mussel survey information has been compiled.

Water and stream habitat quality improvements have made it possible for mussel populations to expand in some river reaches and may lead to augmenting depleted or reintroducing extirpated mussel populations in other streams. Such improvements in habitat conditions have come to fruition in parts of the Cumberlandian Region through the concerted efforts of the TVA, EPA, and other Federal agencies, State water resources and natural resources agencies, industry, municipalities, conservation organizations, and concerned citizens. For instance, TVA has modified water releases from several of its dams to improve water quality conditions in the tailwaters.

State and federal agencies and the scientific community have cooperatively developed mussel propagation and reintroduction techniques and conducted associated research that has facilitated the reintroduction of mussels into historical habitats. Reintroduction projects exist for the Tennessee River at Muscle Shoals, Alabama, a site that historically held more species of mussels than any other mussel beds worldwide. A final rule to reintroduce 16 federally listed mussel species and one aquatic snail to the remaining habitat of the site below Wilson Dam and a final rule to reintroduce 15 freshwater mussels, one freshwater snail, and five fishes in the Lower French Broad and Holston rivers will allow for recovery activities in these areas (66 FR 32250-32264, 72 FR 52433-52461). Reintroduction of the slabside pearlymussel into some of these stream segments, where the species historically occurred, is becoming more of a reality due to these efforts.

Public outreach and environmental education play a major role in our recovery and restoration programs, thus benefiting aquatic species such as the slabside pearlymussel. Working with the Service and various other federal agencies through a private company, the Tennessee Aquarium in Chattanooga, Tennessee, recently installed an imperiled streams exhibit featuring mussels. A large series of brochures, posters, videos, and other materials on subjects such as mussels and fishes, the importance of high water and habitat quality, and stream restoration techniques have been developed for public dissemination.

The slabside pearlymussel historically occurred in Cumberlandian Region streams that drain four states and two Service regions: Region 4 (Alabama, Kentucky, and Tennessee) and Region 5 (Virginia). Endangered species biologists in Region 5 supported Region 4 in efforts to elevate this species to candidate status. In addition, we have contacted resource managers with the U.S. Geological Survey, EPA, TVA, TNC, Natural Heritage Programs, and State fish and wildlife agencies in these states. These agencies and organizations also supported elevation of the slabside pearlymussel to candidate status.

We have not personally contacted private landowners. However, realizing the importance of riparian landowners, who are crucial to the success of aquatic ecosystem management (Neves *et al.* 1997, pp. 77-78), our partners, most notably TNC, have contacted landowners. TNC has worked closely with scores of cooperative riparian landowners in slabside pearlymussel streams (e.g., Clinch, Powell, Paint Rock, Duck Rivers) to restore riparian buffers and protect water and stream habitat quality. If listed, the slabside pearlymussel will become more of a focus organism in project watersheds. With our partners, we will seek an increasing involvement of private landowners to restore and protect habitats essential for this species' continued survival and recovery.

SUMMARY OF THREATS (including reasons for addition or removal from candidacy, if appropriate)

Primary threats that currently affect this species include various habitat and water quality degradation factors that include reservoir operations, mining activities, contaminants, sedimentation, and population fragmentation. We find that this species is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is

threatened or endangered in a significant portion of its range.

RECOMMENDED CONSERVATION MEASURES

General conservation measures include habitat conservation and restoration, water quality improvements, developing propagation technology to augment extant and reintroduce extirpated populations, and public outreach.

LISTING PRIORITY

| THREAT | | | |
|--------------------|-----------------|-----------------------|-----------|
| Magnitude | Immediacy | Taxonomy | Priority |
| High | Imminent | Monotypic genus | 1 |
| | | Species | 2* |
| | Non-imminent | Subspecies/population | 3 |
| | | Monotypic genus | 4 |
| | | Species | 5 |
| | | Subspecies/population | 6 |
| Moderate to Low | Imminent | Monotypic genus | 7 |
| | | Species | 8 |
| | | Subspecies/population | 9 |
| | Non-imminent | Monotypic genus | 10 |
| | | Species | 11 |
| | | Subspecies/population | 12 |

Rationale for listing priority number:

Magnitude: The 10 remaining populations of the slabside pearlymussel face serious threats to their continued existence. Current threats include impoundments, sedimentation, small population size, isolation of populations, gravel mining, municipal pollutants, agricultural run-off, nutrient enrichment, and coal processing pollution. Considering the significant restriction in range, decline in population size, and level of habitat degradation of the slabside pearlymussel, we consider these ongoing threats to be of high magnitude.

Imminence: Threats to the slabside pearlymussel discussed above could result in extinction of the species due to the exceptionally small numbers estimated at nearly all of the extant locations. Available information indicates that regular recruitment is occurring in four populations at best, and that other populations may not be viable. Although there are on-going attempts to alleviate some of these threats, there appear to be no populations without significant threats and many threats are without obvious or readily available solutions. Threats from coal mining activities are increasing in the Clinch and Powell River drainages, putting their slabside pearlymussel populations at increasing risk of extirpation. Two significant populations have clearly declined

in recent years (i.e., Middle and North Forks Holston River) and several others may be on the verge of extirpation (e.g., Powell, Hiwassee, Elk Rivers; Big Moccasin, Bear Creeks). Because these threats are ongoing, they are imminent.

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No

While the species is facing imminent threats of high magnitude, the threats are chronic and ongoing. We know of no projects or other threats being proposed in the short term that would warrant emergency listing.

DESCRIPTION OF MONITORING

Although specific monitoring for the slabside pearlymussel generally does not take place, periodic field work occurs in most of the streams with extant populations of this species. This work is conducted by several colleagues with whom we keep in close contact through phone conversations, electronic messages, and regular meetings (at least once annually). The data is written up in grey literature reports or published in scientific journals. Several stream surveys have been conducted in recent years, many of which staff members have been intimately involved with (e.g., assisting in field sampling, manuscript reviews, technical assistance) and/or will serve as authors when they are published in the peer-reviewed literature. Intensive stream surveys over the past several years include Middle Fork Holston River, Virginia; North Fork Holston River, Tennessee and Virginia; Paint Rock River, Alabama; and Duck River, Tennessee. In addition, USGS and Virginia Polytechnic and State University (Virginia Tech) continue to conduct periodic (five year) quantitative sampling in the Clinch and Powell Rivers, Tennessee and Virginia, the most recent year being 2008. Periodic quantitative sampling sites are being established in other streams (e.g., Duck River) with populations of this species. In this way, we keep track of the general status of a suite of imperiled mussels, both listed taxa and species of concern, in addition to the slabside pearlymussel.

COORDINATION WITH STATES

Indicate what information was sent during coordination with states: The most recent version of the Continuing Candidate Form was sent out to states while soliciting updated population status information on the slabside pearlymussel. This was done via email sent February 22, 2010.

Indicate which State(s) did not provide any information or comments: Mississippi

Contacts:

Alabama—Jeffrey T. Garner, Alabama Department of Conservation and Natural Resources, 350 County Road 275, Florence AL 35633; bleufer@aol.com; 256/767-7673

Mississippi—Robert L. Jones, Mississippi Museum of Natural Science, 2148 Riverside Drive, Jackson MS 39202; bob.jones@mmns.state.ms.us; 601/354-7303 X 113

Tennessee—Don W. Hubbs, Tennessee Wildlife Resources Agency, PO Box 70, Camden TN 38320; tnmussels@aol.com; 731/584-9032

Virginia—Michael J. Pinder, Virginia Department of Game and Inland Fisheries, 2206 South Main Street, Suite C, Blacksburg VA 24060; mike.pinder@dgif.virginia.gov; 540/961-8387

STATES THAT INCLUDE THE SPECIES IN THEIR WILDLIFE ACTION PLANS

Indicate which State(s) (within the range of the species) include the species in their WAPs:

Alabama, Mississippi, Tennessee, Virginia

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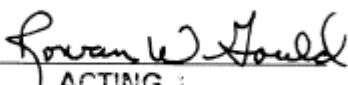
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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve:  June 15, 2010
for Regional Director, Fish and Wildlife Service Date

Concur: 
ACTING
Director, Fish and Wildlife Service Date: October 22, 2010

Do Not Concur: _____
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: March, 2010
Conducted by: Stephanie Chance, Cookeville, TN Field Office